



Makerspaces for Learning, Living & Sharing

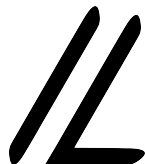
Playbook from the 2022 Unconferences
on Facilitating Learning in FabLabs,
Makerspaces and Open Creative Spaces

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Chair in educational leadership in
innovative pedagogical practices
in digital contexts – National Bank



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Contents

1 Preface

5 Topic 1: Lessons Learned from COVID-19:
What to Do When Your Makerspace is Closed

15 Topic 2: Building a Network

25 Topic 3: Preparing Facilitators

43 Topic 4: Building Community

63 Topic 5: Making in Formal Education Contexts

79 Topic 6: Maker Kits

99 Credits

Preface

This playbook is for anyone who cares for a makerspace, FabLab or an open creative space, or who wishes to build one. Whether you want to get inspired from others' experiences to start, maintain or revive a space or simply read about a particular topic, such as how to adapt to COVID-19, you will find something interesting. We designed the playbook as a Q&A, so you can read it from the first to the last page, or you can search for the topics or questions that interest you.

This playbook emerged from the Unconference Events on Facilitating Learning in FabLabs, Makerspaces and Open Creative Spaces in 2022. These unprecedented events brought together over 80 practitioners, scholars and students who are actively involved in the facilitation of maker education within schools, colleges, universities, libraries, museums and community centres. It was an opportunity for practitioners who are involved in maker education to get together and exchange new contemporary living knowledge emerging from different locations. Most of the participants were from Québec, but as the events unfolded and were shared online, new participants joined from other Canadian provinces, the United States, the United Kingdom and Africa.

Over 30 experts and leaders in the domain were interviewed to identify the topics: covid adaptations, creating a network of makerspaces, preparing makerspace facilitators, community engagement and sustainability of makerspaces, making in formal education and maker kits. We prepared [podcasts](#) to announce the topics and invited participants to brainstorm with us on seven different dates. A total of 17 discussion leaders from 14 organizations (Collège Saint-Sacrement, Polyvalente Lavigne, Lower Canada College, Académie Sainte-Thérèse, Dawson College, LEARN Québec, LESPACEMAKER, FabLab LLIO, Digital Moments, Concordia University Technology Sandbox, Communautique, Chalet Kent, Musée de la civilisation, Université Laval) helped spark and moderate the discussions.

The events were organized by Dr. Ann-Louise Davidson (Concordia University) and Dr. Nadia Naffi (Université Laval) with the collaboration of three students: Nathalie Duponsel, Houda Jawhar and Geneviève Lamarche. The playbook was designed by Don Undeen, also a student. This project was made possible with the support of a Connections Grant from the Social Sciences and Humanities Research Council and the collaboration of the Musée de la civilisation (Québec).

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The background of the slide features a close-up photograph of a 3D printer's nozzle and gears. The nozzle is positioned at the top center, with various colored wires (red, blue, yellow) connected to it. The gears and mechanical parts are visible below the nozzle. The image is partially obscured by a large teal semi-transparent shape that contains the title and a text box. The overall color palette is dominated by teal, purple, and blue.

1. Lessons Learned from COVID-19: What to Do When Your Makerspace is Closed

When the first case of COVID-19 was discovered in Québec, we were far from thinking that many makerspaces would be closed. The initial two-week closure ended up being much longer than expected and we will hopefully never have to relive these events. What makerspace facilitators learned during that time remains invaluable advice about how to maintain activities and keep communities active during times of social distancing. What follows is a series of Q&As that stem from conversations we held with participants during the unconference event on that topic.

Q In the event that the makerspace is not physically accessible, what do we need to consider to keep our maker community thriving?

Make sure users have ways to continue making

Makerspaces are about making. During events like COVID-19 when makerspaces are closed, facilitators and leaders need to find ways to keep their community engaged in making. Here are some examples of what can be done when the makerspace is closed:

Videoconferencing

Videoconferencing with members is a great way to keep people connected and actively making. Online maker meet-ups, Gather.Town meetings and online maker jams are excellent alternatives to in-person gatherings.

Online workshops and

tutorials Workshops are among the most popular activities in makerspaces. Creating online workshops and tutorials can keep people connected, teach them new skills and keep them engaged in making.

Resources for online workshops and tutorials

Campus Recit
<https://bit.ly/3xk74gE>

Campus Récit YouTube
<https://bit.ly/3QpBs4>

Kids Code Jeunesse
<https://bit.ly/3tXm979>

Le Square BANQ
<https://bit.ly/3Hq9fnp>

Education Makers Projects
<https://bit.ly/3MKHZ41>

LearnQc YouTube
<https://bit.ly/3tzoDrM>

Equipment rentals or loans

Some projects just have to be done with the real thing! When users can't go to the makerspace, the equipment can go to them! Robotics and microcontroller kits like Arduino and Micro:Bit and small desktop digital fabrication tools like 3D printers can be loaned out to experienced and responsible users.

Online simulations

Vector drawing software, 3D modelling, building circuits and programming are all activities that can be done online to help users develop their skills and prepare their projects for when they return to the makerspace.

Relay production

When health measures prevent people from working on a project simultaneously, break the project into parts that each person can contribute to one-at-a-time. This can be an excellent way to get that sense of collective pride while still respecting health measures!

Low tech making

Go low tech! A lot can be done with cardboard, tape, and some bottle caps. By using materials that people have at home, the making can continue!

Resources for online simulations

<https://www.tinkercad.com/learn/circuits>

<https://wokwi.com/>

<https://inkscape.org/>

<https://www.gimp.org/>

<https://www.sketchup.com/>

<https://www.tynker.com/?t=reset>

<https://vr.vex.com/>

<https://codepen.io/tholman/pen/YNEvda>

<https://robotbenchmark.net/>

<https://gocoderz.com/>

<https://www.microsoft.com/en-us/>

Resources for low-tech making

Georgetown Maker Hub: Prototyping from Home: <https://bit.ly/3BggAVN>

Make sure users have ways to continue connecting with each other

There are many ways to ensure that users can continue to connect with others. Here are some examples of what you can do:

Keep the communication flowing

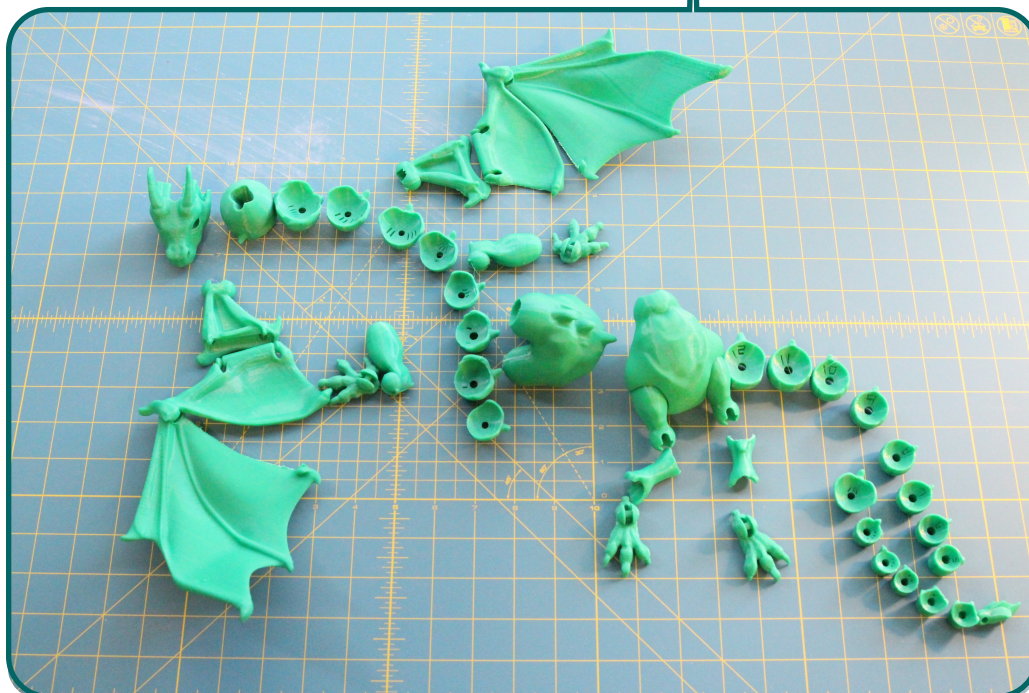
- Use communication platforms like Slack, Discord, GroupMe, etc.
- Spread information through existing networks
- Share projects with tools like Flipgrid and Padlets

Engage the community in online activities

- Invite the community to participate in designing solutions for the online/hybrid environment
- Organize online making sessions
- Invite experts to run workshops and produce tutorials

Find ways to collaborate

- Initiate portable projects (e.g. pop-up makerspaces, send Arduino kits to users)
- Create a shared project in which all members of the community can be involved (e.g. create a big build that can be created in small pieces individually and assembled later)



Keep the atmosphere positive in the makerspace community

The pandemic was hard for everyone and it was easy for many to lose their motivation. Here are some examples of what makerspace facilitators did to keep makers making:

Celebrate small accomplishments to recognize what people are doing

Focus on what is working and what people are up to. Write some shout-outs online when makers accomplish something!

Create a shared reservation system to help people feel safe

If the space can be accessed by a limited number of people at a time, have a reservation system so that people can plan their time in the space and feel safe while there.

Create opportunities for virtual visits/tours

Virtual reality is a great technology that can give people the impression of being out and about when they can't visit places in-person. Share links to places that offer virtual tours that can also inspire ideas for your makers.

Find ways for people to make away from the computer

Screen fatigue is real and people need opportunities to work away from their computer. Provide inspiration by sharing project ideas that will get them making with their hands, preferably outdoors.

Have online social meet-ups that are not necessarily all about making

Making is also about socializing, and people need that during a pandemic more than ever. Have meet-ups that are just about socializing to improve your users' well-being.

Resources for virtual tours

<https://www.musees.qc.ca/fr/musees/visites-et-experiences-virtuelles>

<https://www.mcq.org/fr/expositions/en-ligne>

<https://www.louvre.fr/en/online-tours>

Plan with a shared calendar to excite people

Show people the community is still active and there's plenty to do!

Listen to your community and involve them in solutions

Users may have needs you are not aware of. Include users in the planning to be sure to address their needs as well as give them a sense of control during a time when they have less control than they are accustomed to.

Connect with other maker communities

This is an excellent time to connect with other makers to share and learn new project ideas, resources and practices.

Try something
new!

You may be
surprised with
what you
discover!

Case Study: Outdoor Maker Project



"The École du Triolet is a school located in the woods. During recess, the students play and build makeshift huts with branches, trunks and other natural elements that they find in the woods. Why not build real huts with them? This is what we did. We enlisted the help of parents and the City to provide us with wood and materials. The 4th graders drew the plans and presented them to the physical education teachers. Once the plans were approved, parent volunteers came in and, with the help of a City carpenter, the students built the cabins in one-hour shifts."

Marc-André Girard
School Principal

Q Makerspaces had to make a lot of adjustments during the pandemic. Many of these adjustments turned out to be beneficial in the long-run. Which of these adaptations should we consider implementing in our makerspace?

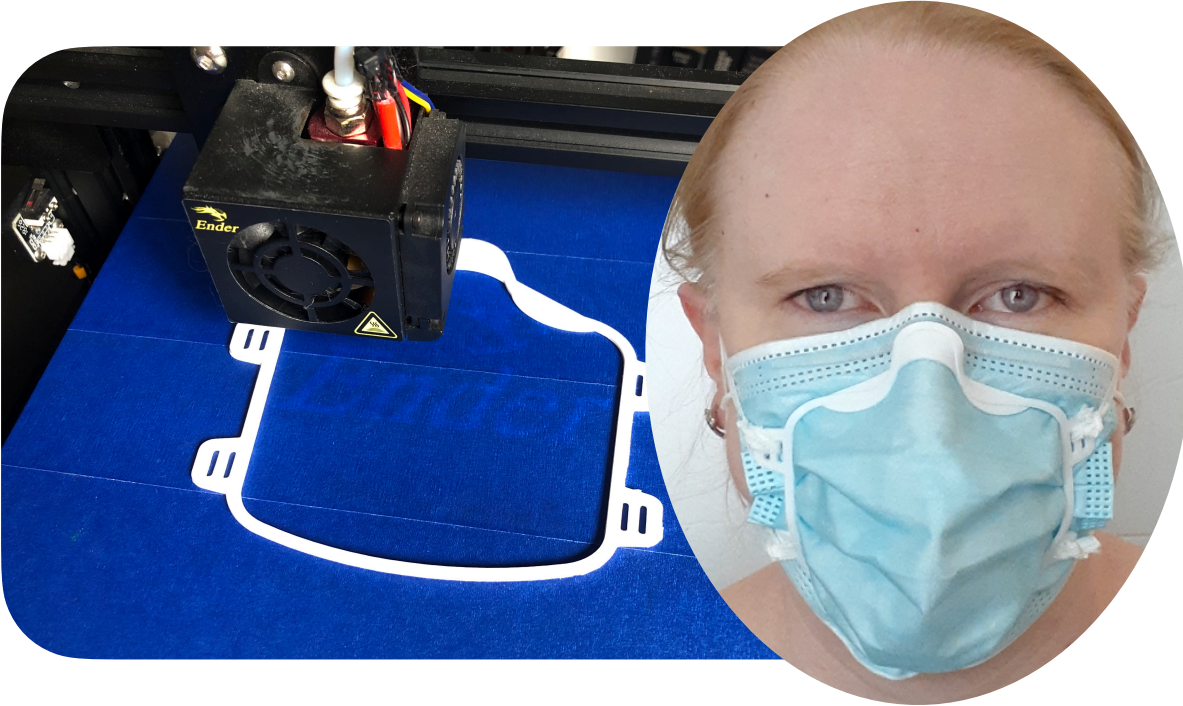
Reservation systems: Many makerspaces created reservation systems for their spaces, equipment and time with their facilitators in response to public health requirements. As it turned out, these reservation systems helped the spaces run more smoothly even once the pandemic was over.

Loaning kits: Loaning kits can allow people to dedicate more time to making even when they cannot access the makerspace.

Co-modal and hybrid activities: Doing activities online synchronously and asynchronously can expand the makerspace's network of makers while being inclusive of those who cannot make it to the physical space.

Social/societal issues solutioning: Many makerspaces were instrumental in responding to PPE shortages during COVID. They found their efforts very gratifying and plan to continue contributing by responding to community, social and societal needs on a more permanent basis. Consider making a contribution of your own!

Case Study: Makers respond to COVID PPE shortages



During the first wave of COVID when sudden increases in demand for personal protective equipment (PPE) resulted in supply shortages, many makers helped out by creating temporary alternatives to help protect medical professionals and frontline workers. One such project investigated how to use certified surgical masks more effectively with a 3D printed mask frame. The details about the project are available on Instructables.

<https://www.instructables.com/Making-Better-Fitting-Facemasks-With-a-Quick-3D-Pr/>

The background image shows a makerspace event. In the foreground, there are several 3D printed objects on a table, including a large red and white striped rocket, a yellow fan-like structure, a green frog-like object, and various small blue and yellow parts. In the background, people are visible, some looking at a display, and there are blue string lights hanging from the ceiling. A large blue circular graphic is overlaid on the right side of the image.

2. Building a Network

Makerspaces can exist on their own, but when they are networked they are much stronger. They can benefit from being part of broader networks, without having to adhere to a charter if they don't wish to, but still share services they offer, expertise they developed or equipment they own. What follows is a series of Q&As that stem from conversations we held with participants during the unconference event on that topic.

Q What are the advantages of being part of a network of makerspaces?

Connecting with other groups of makers can result in benefits including:

Person-to-person connections: Connecting makers from different spaces opens opportunities for people to connect and share different perspectives, skills, and inspiration that they might not get from their local group.

Organizational synergies: Makerspaces in different areas can connect for unique partnerships. This allows for more types of activities that one space couldn't do on its own and learning from the experience of others by sharing best practices.

User mobility: Participating in a network of makerspaces opens opportunities for members of all participating makerspaces to access and make use of resources in all network makerspaces. Depending on what agreements your participating spaces make, this could include portable skill and safety credentials, memberships, and/or resource credits (aka "maker bucks")

Resource sharing: Sharing physical and human resources among the spaces can expand the resources available to the users within the network.

Examples of resources that can be co-developed and shared

Provide guides on equipment maintenance. Create age-appropriate guides for activities, trainings and tools.

Create a resource library of available human and material resources in the network and where to find them.

Develop a common agreement on safety and security procedures.

Develop media production guides for skills, tools and workshops.

Create local supplier lists.

Q What could our makerspace offer a network of makerspaces?

Every makerspace is unique and so is yours! What makes you special can have value to other spaces in a network. Some aspects to consider include:

The following pages contain worksheets you can fill out to identify qualities that offer value to other makerspaces in your network. These worksheets are best filled out in conversation with your community. Consider hosting ideation/brainstorming sessions to address these questions.

Your makerspace identity

Every maker community has a unique history of cultural influences, perspectives, and interests that forges their space's identity. Ask yourself:

How did you create a sense of community among your members?

How do you express your space's identity?

What practices can you share with other makerspaces who are trying to create their own makerspace identity?

[sample response: "Our users come from cultures that highly value traditional crafts. We decorate our space and regularly include many of these crafts in our space's activities to emphasize this aspect of our identity."]

Worksheet: What is your makerspace's unique cultural identity?
How did you create a sense of community?

Your story

Every makerspace has a unique story and many hoops had to be jumped to make things happen. How you made it work for you matters because it can help others. Ask yourself:

What obstacles did you have to overcome to get your space started and running smoothly?

What did you learn along the way?

How can your experiences help others?

[sample response: *"We worked with city government to find unused downtown spaces to get breaks on rent."*]

Worksheet: What's your unique story? Jot down some highlights in discussion with your community.

Case Study: Chalet Kent Makerspace



The Importance of Building a Makerspace Culture

The Chalet Kent Makerspace is housed at the Maison des Jeunes – Côte-des-Neiges, a youth centre in Montreal, Canada. The space was created in a partnership between the Director Karl-André Saint-Victor and Ann-Louise Davidson, Concordia University Research Chair in Maker Culture and the director of the Innovation Lab at Concordia University, thanks to funding they received from SSHRC. Chalet Kent Makerspace offers the youth of the neighbourhood a place to learn, innovate, and express their creativity. Creative expression and problem solving have always been present in the local Côte-des-Neiges community, however building confidence in STEM sciences is sometimes challenging for youth. Before the Chalet Kent Makerspace became an integral part of the centre's activities, a culture around making needed to become part of the already existing culture at Chalet Kent. By combining maker workshops that complemented already existing activities at the centre (also including good food and music!), the youth quickly saw the value of the makerspace and began using it in a variety of ways. Today the space is an integral part of the community.

Q What can makerspaces do to strengthen and expand the network and encourage collaboration among users and spaces?

Site visits

- > Other makerspaces
- > Hackerspaces
- > Design studios
- > Other “maker-adjacent spaces”
- > Cultural centres/museums
- > Craft groups
- > International VR visits

Co-organized events

- > Maker Faires
- > Networking events
- > Demonstration days
- > Open house events
- > Crowdsourcing maker projects that raise funds for network needs
- > Webinars
- > DIY fixing/repairs shops

Co-making activities

- > Collaborative projects between makerspaces
- > Progressive projects through many spaces virtual or IRL
- > Group designathons, makeathon, hackathons, collaborathons, ideathons, solutioning



3. Preparing Facilitators

Makerspace facilitators need a mix between soft skills (creativity, empathy, collaboration, emotional intelligence, etc.) and hard skills (knowledge of programming, circuits, 3D modelling, etc.). Most start with a specific subset or mix of skills and set professional development objectives depending on the needs of the makerspace and the community of users and participants. The fine blend of acquired skills and to-be-developed skills that are needed is very nuanced. What follows is a series of Q&As that stem from conversations we held with participants during the unconference event on that topic.

Q We are starting a makerspace and want to hire maker facilitators. What skills and attributes should we look for in candidates?

The following pages contains a series of worksheets which identify common skills, and provide a space for you to add your own assessment of those skills, either within your organizations or on an individual level.

It could be useful to print these pages for each of your facilitators, to identify areas for improvement or training.

Space is also left to add additional skills specific to your space's needs.

Maker related skills (digital and manual)

The role of makerspace facilitators is to guide users as they work on their projects and ensure their safety. Aside from having a basic understanding of the context of the maker movement, they should have a minimal proficiency in the following areas:

Skill	Your Assessment
Coding	
Circuits and Electronics	
2D & 3D Design	
Operation and Maintenance of common digital fabrication tools	
Use and maintenance of common manual and power tools	

Interpersonal skills

It's no surprise that makerspace facilitators need to have solid interpersonal skills. Some of the key interpersonal skills to look for include:

Skill	Your Assessment
Emotional Intelligence/ empathy	
Knows when users are getting frustrated and need help	
Knows when users need to be challenged	
Openness to others	
Conflict resolution skills	
Listening skills	

Interpersonal skills (continued)

Skill	Your Assessment
Creates a positive atmosphere	
Empowers others	
Encourages collaboration among users, especially during problem-solving phase.	
Fosters good feelings/ well-being among users	
Communicates with teams (team-player)	

Intrapersonal skills

It is of essence that a facilitator can self-regulate and work independently. Keep the following intrapersonal skills and attributes in mind as you consider possible facilitators:

Skill	Your Assessment
A do-er –someone who takes initiative	
Open-minded	
Explorer	
Curious	
Flexible –accepts to fulfil a role even if they don't know everything	
Growth-mindset	
Lifelong learner	
Willingness to learn from others	
Spontaneous	
Adaptable	
Flexible	

Pedagogical/andragogical skills

Makerspace facilitators help users to learn to design and solve problems on their own so that they can be as independent as possible. Facilitators require some skills and understanding about how people learn. When hiring makerspace facilitators, we suggest looking for the following pedagogical/andragogical related attributes:

Skill	Your Assessment
<p>Confident Look for someone who has enough confidence in their own abilities and does not feel the need to prove themselves. This will allow them to give space for users to learn more autonomously and be more self-regulated.</p>	
<p>Idea-processing Look for a facilitator who can help people break down their ideas into manageable steps without taking over the project.</p>	
<p>Capable of stimulating creativity Being creative is important as a facilitator, but helping others engage in the creative process is even more useful.</p>	

Pedagogical/andragogical skills (continued)

Skill	Your Assessment
<p>Adaptable and flexible Facilitators need to be able to adapt to various levels of experience and learning approaches. They also need to be flexible so that they can follow the user's pace and move in the direction of their interests.</p>	
<p>Fosters the love of learning Many people have been marred by their education experience and don't feel comfortable in learning spaces. Facilitators need to rekindle the love of learning and show users the benefits of learning new things in an authentic way.</p>	
<p>Thinks out loud Facilitators can be excellent models of how to learn and problem solve. Choose someone who can describe their thinking process to make it accessible to users.</p>	

Pedagogical/andragogical skills (continued)

Skill	Your Assessment
<p>Encourages trial and error and learning from failure People are not accustomed to being allowed to fail, especially not in learning spaces. Hire someone who can help them take creative risks and learn from failure.</p>	
<p>Encourages discussion and reflection Trial and error needs to be coupled with reflection to result in learning. Facilitators need to help users to discuss and reflect on their observations to learn from them.</p>	
<p>Challenges the users People love to be challenged! Understanding when and how much to challenge users is no easy task. Find someone who can gauge well when a participant needs to be challenged versus supported.</p>	

Transversal skills:

Transversal skills are skills that are useful across contexts and not necessarily to just one type of occupation or expertise. Transversal skills that are particularly useful for maker facilitators include:

Skill	Your Assessment
Creativity	
Problem solving	
Improvisation	
Observation	
Independent learning	
Detail-oriented	
System-oriented (capable of seeing the whole picture)	
Workflow-oriented	

Global citizenship skills

Skill	Your Assessment
Cultural awareness	
Environmental awareness	
EDI (Equity, Diversity, Inclusion) awareness	
Digital citizenship*	

* To learn more about Digital Citizenship, see "The Nine Elements of Digital Citizenship" <https://www.digitalcitizenship.net/nine-elements.html>

Q What types of training do facilitators need before working with users?

On-boarding related to the specific makerspace

- Safety training with equipment
- Values of the space
- "Charter" or "Code of conduct" at a FabLab
- House rules at a makerspace
- Expectations of others in the space
- Layout of the space
- Training requirements before using equipment
- Structure of organization and who is responsible for what
- The history of the space and local community
- Getting to know the makerspace users
- Getting to know the local community
- Partners working with the space

Basic maker skills

- Further training on basic maker skills not yet developed (see maker related skills on page 27)
- Application of skills on machines and equipment available in space
- Complete a small project or challenge on each machine
- Training on creative/innovation processes

Pedagogical training

- How to guide, and not to teach
- How to make thinking processes accessible to users
- How to find project ideas that correspond to user interest and ability
- How to be inclusive of users with special needs
- How to be inclusive of cultural differences
- Knowledge of the school curriculum (if the makerspace is working with the local education system)

Interpersonal training

- How to create boundaries
- How to set users' expectations
- Conflict resolution

Q Apart from training, how else can we support our facilitators in the makerspace?

Provide opportunities to continually develop skills

- > Give them occasions to lead
- > Give them time for experimentation
- > Offer them the option to create projects outside their field of expertise
- > Allow them to design their own workshops
- > Give them the freedom to create new projects and initiatives
- > Connect them with external experts for advanced training
- > Ensure that they evolve in a well organized and structured framework

Create an environment to try new things and learn from failure

- > Be open to their ideas
- > Provide them with emotional and creative support
- > Foster a sense of belonging
- > Allow them to follow their interests
- > Provide them with feedback on their performance
- > Include them in creative processes and projects
- > Provide team building opportunities
- > Encourage networking with other spaces
- > Pay them (volunteerism is privilege)

Q What kind of independent learning should facilitators engage in to foster continual growth?

Facilitators can foster their own growth in many ways. Here are a few examples of what they can do:

Follow new tech developments online

Interact with other makers and facilitators

Try new projects and initiatives

Participate in online maker communities

Tackle complex problems or challenges to broaden their skillset

Attend other makerspaces' activities

Case Study: How do you bring people together around a project?

"I'm not an expert on anything. I like people and finding solutions to the problems that are presented to me. When a project is explained to me, I consider the challenges of the functioning and execution. How do you get from an idea to reality? I think about the ways and the people that will help materialize the concept. I think about assembling human expertise and try to connect the dots.

The beauty of a shared workshop is the breadth of knowledge that comes together. The larger the community, the more varied and qualified the skills, the more diverse the techniques, and the greater the potential for achievement.

When we recently discussed the development and the potential establishment of a glass workshop at LESPACEMAKER, an entire glass community was mobilized and signified the importance of being able to share glass in a free and open context in Montreal. We gathered this community and invited several professional members of LESPACEMAKER to join the discussion (engineers, architects, video artists, and communicators). We visited the workshops of Espace Verre (a school workshop affiliated with CEGEP du Vieux-Montréal) and thought about the scope of the challenges this project will entail.

Currently, we envision three phases of development for the glass studio at LESPACEMAKER: cold work and thermoforming, flashlight work, and blowing. We envision building much of the equipment (kilns and furnaces) using the expertise and workshops that are already in place. Several members of our community built Flame Effects at Burning Man, so it stands to reason that constructing a "Glory Hole" for the glassblowing community would be a good fit. And when glassmakers meet fire sculptors, who know what will come of it..."

Arno Robin
Co-founder and coordinator at LESPACEMAKER
<https://www.lespacemaker.com/en/>

Q What kinds of skills does a facilitator need to work on projects with groups of users? Do these skills vary greatly between projects? Do they vary depending on the group size?

The types of skills needed to facilitate a workshop or project depends heavily on the complexity of the project, as well as the number and skill level of participants.

During the unconference events, participants shared a number of simple to complex projects that require a variety of skills depending on the size of the group. Here are some examples you can be inspired by:

<p>Easy project/large group</p> <p>Button Making</p> <p>Description: Participants design small images either by hand or using graphic software and then make buttons (pin badges) using a button making machine and the drawn/printed images. Once designed, each button takes seconds to assemble. This activity is ideal for large groups.</p> <p>Skills required: Basic maker skills – drawing, mixed media, graphic design Interpersonal skills – large group management (if working with children)</p>	<p>Complex project/large group</p> <p>Robotics Competition</p> <p>Description: Many competitions exist where groups compete to complete a task with a robot of their own making. Teachers often work with several groups of students who are competing to create their own unique robot. Before the competition, teachers have to break down the various aspects of robotics to ensure that learners can build the robots and control them.</p> <p>Skills required: Advanced maker skills – robotics, coding, circuitry, soldering, 3D printing, laser cutting Interpersonal skills – large group management, offer guidance without completing the projects for learners, problem solving</p>
<p>Easy project/small groups</p> <p>Micro:bit activity</p> <p>Description: The micro:bit can be standalone or can be used with other hardware components. As an introduction to micro:bits, learners can learn to control the micro:bit by exploring code to control the sensors such as making patterns with the integrated LEDs, creating devices with the light sensor, programming it as a joystick, etc. These activities are ideal for small groups, but with a full class set, the device can be used with larger groups. Ideally learners each have access to one micro:bit each, but they can also work in teams with one micro:bit per team.</p> <p>Skills required: Basic maker skills – knowledge of visual programming with MakeCode for micro:bit, cardboard prototyping skills. Interpersonal skills – observation, offer guidance without doing the coding, problem solving</p>	<p>Complex project/small group</p> <p>Arcade Table</p> <p>Description: A facilitator works with a small group to create an arcade table using reclaimed materials like a small table and monitor, a Raspberry Pi, and buttons and joystick. The activity involves both the use of power tools, circuitry and programming.</p> <p>Skills required: Moderately advanced maker skills – power tool use, construction, circuitry, 3D printing, programming Interpersonal skills – team building skills, observation and safety awareness</p>

Other ideas that were shared by our participants

Novice projects

Introduction to 3D Modelling

Create keychains with big groups (3D print a sample while they learn to do 3D modelling with Tinkercad).

Introduction to Prototyping

Make an invention using Scratch Jr. (video game prototype, robot, etc).

Introduction to Robotics

Create a smart city using BlueBots or any robot that can move around the room.

Paper Circuits

Teach children about basic electronics by creating a circuit that opens and closes by opening and closing a greeting card.

Decals and Stickers

Design a decal or a sticker to cut or print with a vinyl cutter.

Intermediate projects

EV3 LEGO Projects

Offer time for skill and knowledge development regarding the tool, work with real problems and encourage design thinking.

3D Guerilla Art

Use TinkerCAD/Thingiverse to engage in critical Design and engage in 3D printing Realism (what will actually print and work).

Draw Silhouettes

Help people become comfortable with vector drawing on a laptop or tablet, test apps and technology and play with geometry.

Knitting

Knitting projects and knitting circles help create welcoming spaces while learners work through scaffolded experiences and become acquainted with the notion of community, resourcefulness and helping each other.

Community-led projects

Public Market

Bring together artists and artisans to sell what they make, coordinate volunteers, invite new people to join.

Online "Maker Festival" (showing & selling)

Federate your network around peer sharing, plan the event, think of growing your community!

4. Building Community

Makerspaces are about people and the sharing of expertise. Developing communities is not a recipe, however we can use the experience of others to get insight about how to invite people to makerspaces. What follows is a series of Q&As that stem from conversations we held with participants during the unconference event on that topic.

Q There are people out there I think would really like my makerspace. However, they are either not aware of it, or they haven't been in to experience it. How do I make people aware of my makerspace?

It depends on the specifics of your makerspace: its assets, goals, and how it is geographically situated within or near other organizations and communities. Aside from some basic outreach activities, such as Demos, Open-Houses, Online and IRL promotion, our experts identified the value of **KNOWING** your community to plan your outreach.

If your space is situated within a larger organization (ex. school, university, library, etc)

Participate in institutional events and activities to plan your outreach. Go to the local schools to invite classes for visits and workshops. Invite groups of students and associations to specific events.

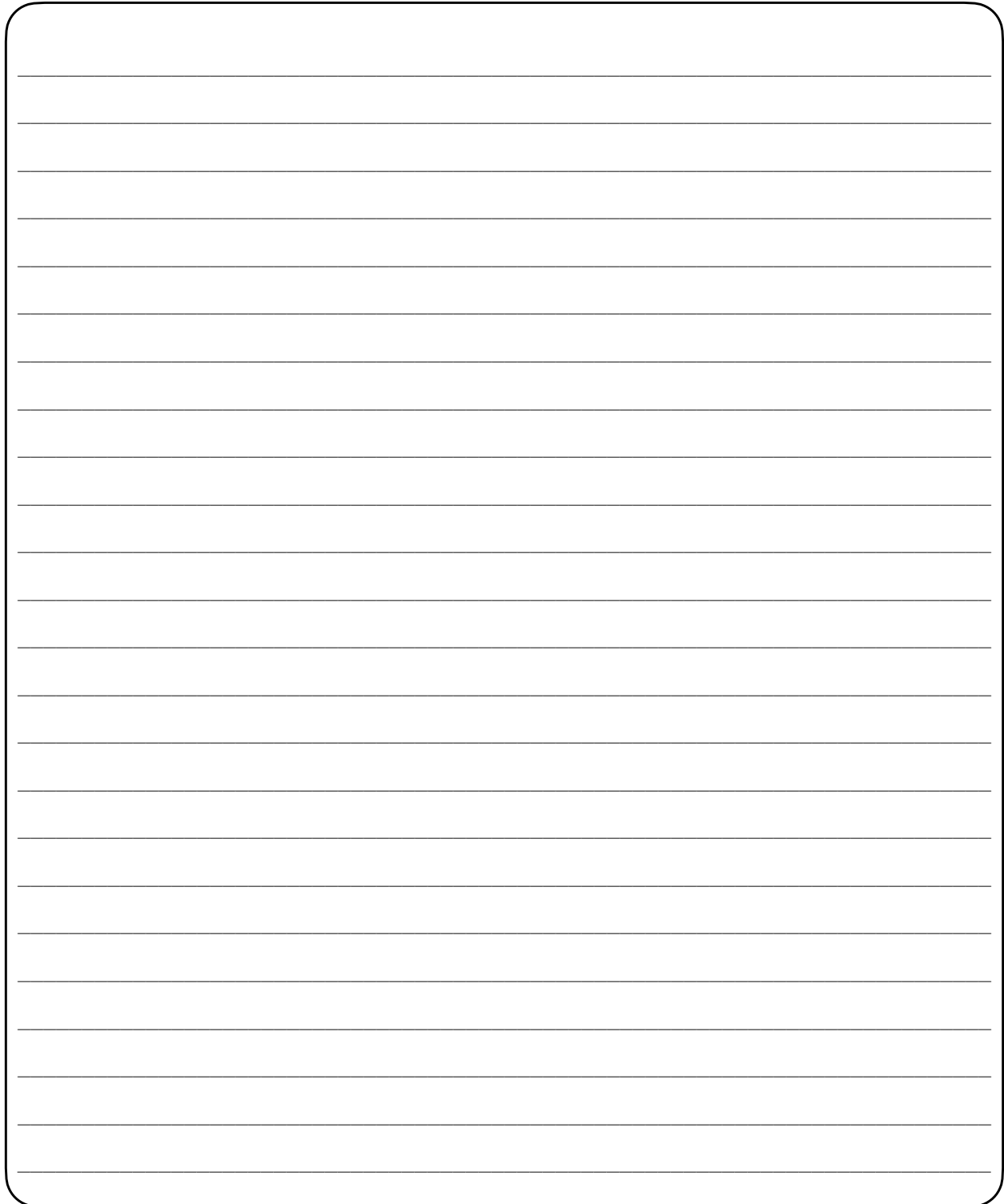
If your space is public

Learn about the needs of people in your area; these are your future users. Go where they are, participate in their activities to show that you're a good neighbour. You will then be better positioned to develop activities targeted specifically to your local communities.

In the following pages you fill in your "S.C.O.R.E" worksheet. It is similar to S.W.O.T., but modified for creative community spaces. We recommend convening a brainstorming group of stakeholders to identify your makerspaces Strengths, Constraints, Opportunities, Risks, and Enthusiasms. This information will help develop your unique makerspace identity with the suggestions and ideas in this chapter.

Strengths

What's great about your space, your community, the economic/political/cultural climate, etc.



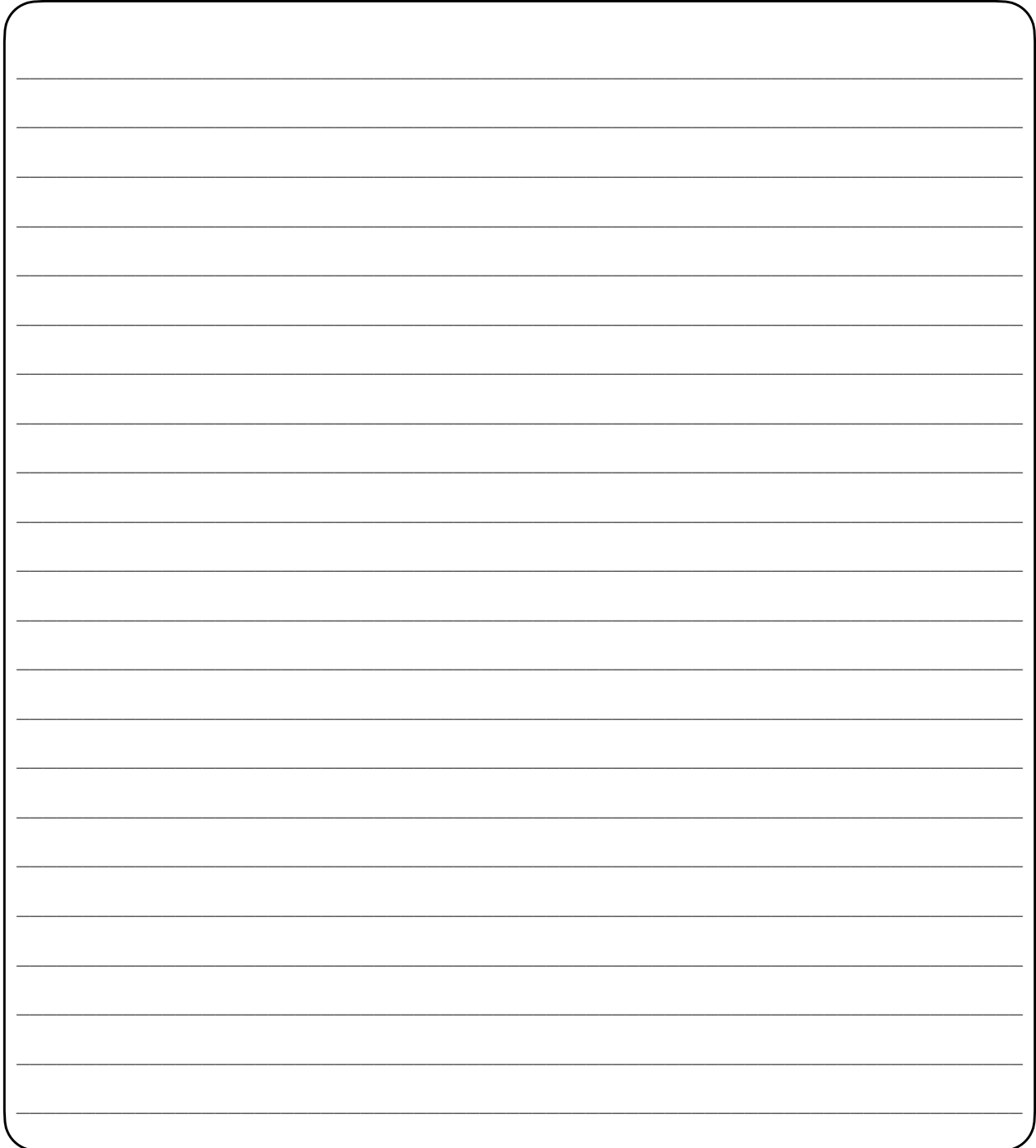
A large, rounded rectangular box with a black border and horizontal lines, intended for writing. The box is empty and occupies most of the page below the introductory text.

Constraints

What is it really hard to do in your institution?

What are your limitations? What takes a lot of time to do? What is socially risky?

"Constraints" are often seen as negatives, but in fact they are often the anchor for your innovation initiatives. They inspire creative problem-solving. By being open about your constraints, you also help set appropriate expectations.

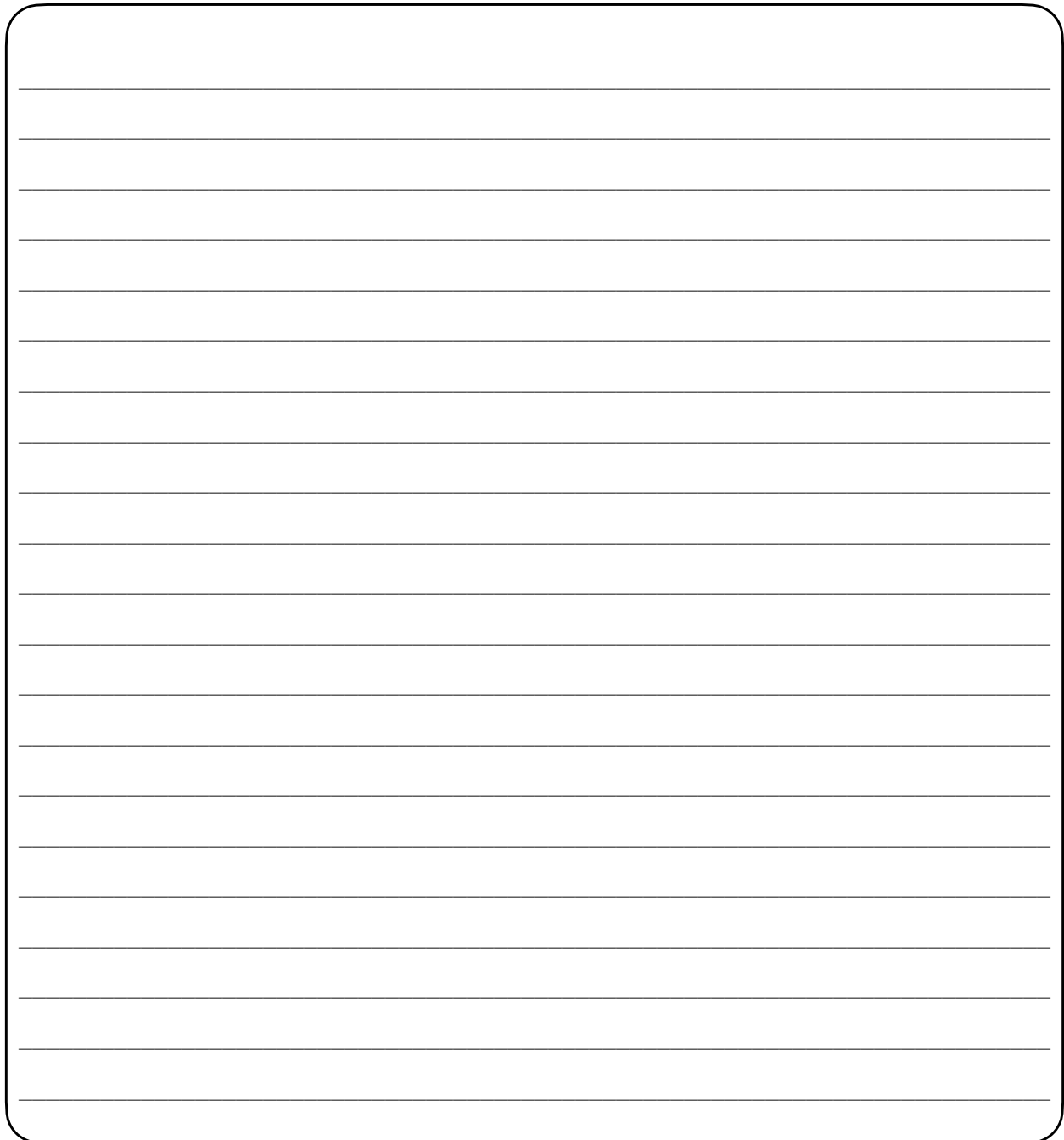
A large, empty rounded rectangular box with a black border, containing approximately 20 horizontal lines for writing. The lines are evenly spaced and extend across the width of the box, providing a space for participants to list constraints in their institutions.

Opportunities

Where do you see the real opportunities for innovation in your institution and broader community?

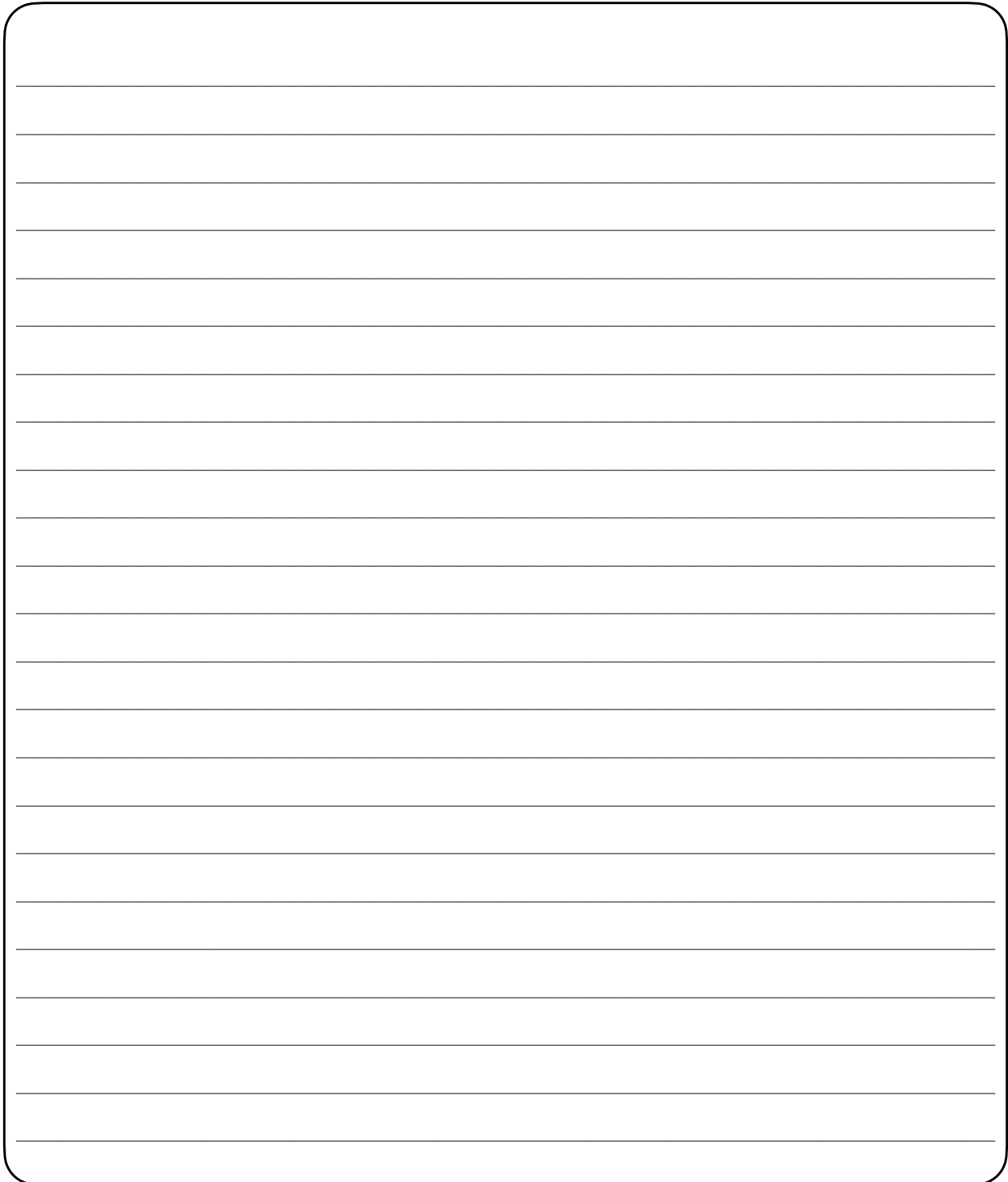
These items aren't fully fledged "project plans," but rather ideas to spend time thinking about.

As your makerspace grows, as you communicate with your community, you will identify a lot more opportunities.

A large, empty rounded rectangular box with a black border, containing horizontal lines for writing. The box is designed for users to list opportunities for innovation.

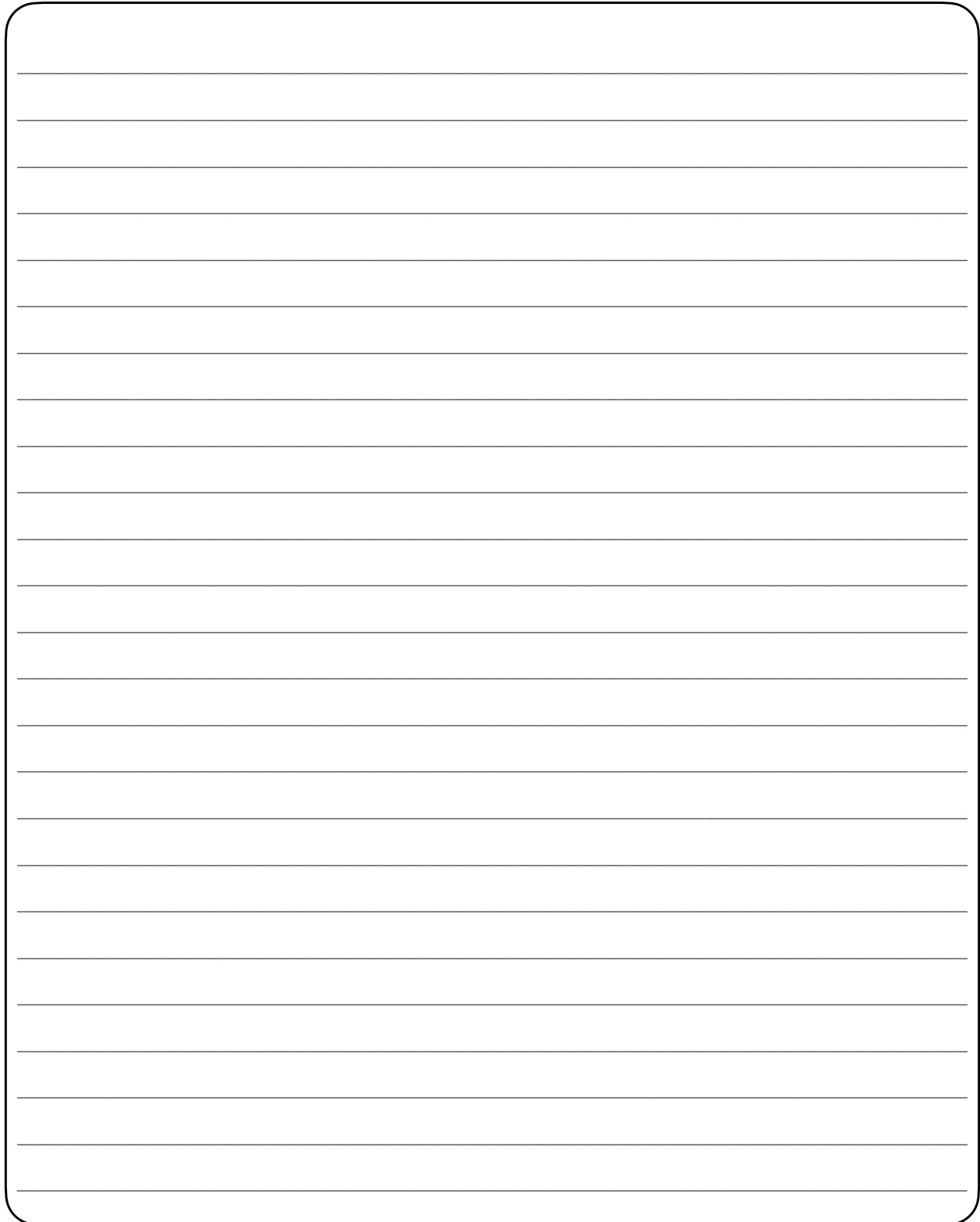
Risks

It's important to be up-front about potential risks to the sustainability of your space. Your makerspace may have cultural sensitivities, a political climate where cultural support is in question, prickly stakeholders, etc.

A large, empty rounded rectangular box with a black border and rounded corners. Inside the box, there are 20 horizontal lines spaced evenly, providing a template for writing notes or a list of risks.

Enthusiasms

What excites your community about your space? What are you enthusiastic about?



A large, rounded rectangular box with a black border and horizontal lines, intended for writing answers to the question above. The box is empty and occupies most of the page's width and height.

Q We are trying to connect our makerspace more closely to the needs of our local community (ie. people who live and work in our area). What do local communities ask from their makerspaces?

Community members tend to want makerspaces to fulfill two roles:

Provide space for making

By providing tools, training and facilitators the makerspace empowers local communities to work on projects that are relevant to their specific needs or passions. It's more important to equip your space with the RIGHT resources, than with the most expensive tools or complex technologies.

Provide space for connecting

By providing a space for people to gather, connect, and support each other a makerspace can meet the needs of an expanded network. An "emotionally intelligent" makerspace can feel like "home" and build deep community support. Local communities often need spaces to meet for non-maker related activities. This can be a great way to get more people in the door.



Idea

Set aside part of your space for showing off and celebrating members' projects, both successes and failures. It's a great way to provide locally relevant inspiration and build connections among members.

Q How can we foster better connections with our local communities?

Involve people from all strands of life in the implementation of your ideas and projects, so they are well aligned with the ambitions and the dreams of your community.

Community-specific outreach and advertising

Word-of-mouth is a good start for connecting to a local community, but developing an outreach strategy that is specific to your community will go further. Some factors to consider:

- Language
- Community interests
- Community gathering spaces (ex. churches, streets, clubs, barbershops, etc.)

Community-specific events

Identify local issues, cultural or historical aspects, holidays, traditions, etc. Work with community members to develop related maker events.

Cultural Inclusion in Makerspaces

Makerspaces can and should be places where people from all cultures feel comfortable to make and create. Some makerspaces, like the Onaki FabLab in Gatineau (<https://www.facebook.com/OnakiFabLab>) and FabLab Wawacte in La Tuque (<https://www.facebook.com/FablabWawacte>) have been created specifically for indigenous youth to develop their skills and confidence in innovation and creation.

All makerspaces should strive to be inclusive of all users and provide opportunities for various cultural groups to share their culture and pursue projects related to their cultural heritage. This can be done by providing the materials and equipment that may not be mainstream in makerspaces, but are relevant

Get involved

Spending time with your local community and getting to know them personally is a great way to build connections. Go to their events, participate in their activities, and invite them into conversations about what your makerspace can do to be a better neighbour.

Accessible projects

Develop and deliver workshops and training designed for first-time users and uniquely relevant to the community. Think outside the box of typical “makerspace” projects with high-tech tools, and consider low-tech projects like knitting, sewing, woodworking, etc.

Build practical connections

When possible, use local businesses for supplies and services. Hire locally, to put your money back into the community.

Q A lot of people come to the makerspace once, but don't come back. They aren't very experienced makers and they don't become regular visitors. How do we get first-timers more involved?

Not every person who visits your space is going to come back, and that's ok! But you do want to make sure that everyone who walks in your door feels welcome and empowered to overcome any initial inexperience or awkwardness. Here are some tricks for creating welcoming environments and getting people started on the "maker on-ramp":

Build a welcoming environment

If people feel like they don't belong, they won't come back. Your facilitators should be trained, and your space and policies should be designed, to make sure people feel welcome when they arrive and while they are there. Some concrete ways to do this include:

- A "welcome" script that every facilitator uses to greet visitors.
- Clear signage that encourages people to ask for help, and makes it clear that everyone was a new user once.
- A seating area designed for "Hanging out," so people don't feel like they need to be "doing something" to be welcome.

Plan introduction activities

It's helpful to have projects, activities, and training modules that are easy to access and start with minimal commitment. These could be short activities to make something simple, or longer projects that are easy to drop in on and contribute to. Open making sessions and open hours can be specifically targeted to first-time users.

Adopt diverse approaches

Some people thrive in an open-ended environment (ex. tinkering during open hours), while others work better within structured activities (ex. scheduled workshops). It's important to design for a range of engagement styles and intergenerational groups. Having a wide range of tools and materials also makes it more likely that a new visitor will see something they find familiar or interesting.

Be relevant

People are more likely to come back when they see the activities as relevant to their interests, goals, and concerns. For example, training in employability skills or workshops specific to a cultural holiday can be very compelling. Listening closely to your community will help you develop meaningful programming.

Offer free or low-cost materials

Help people get started without worrying about the expense of failure.

Case Study: Training new facilitators to greet visitors

The Attitude

The most important space in the maker hub is the first three feet past the door. That's where a new visitor decides that the Maker Hub is a place for them. The most important piece of equipment in the Maker Hub is our staff and volunteers' hearts. It's those welcoming hearts that create a community of creative people making together.

Welcoming Every Visitor: The script

EVERY visitor to the Maker Hub gets greeted with *"Welcome to the Maker Hub, is this your first time?"*

If you're a regular, and a new volunteer asks you if it's your first time, THANK THEM for being awesome. It can feel embarrassing to be a new Greeter, so let's help them out.

If they say "No":

"Great! Just sign in, and let me know if you need anything."

If they say "Yes":

"Awesome! We just need to do a quick safety orientation, have you sign our waiver, register for our swipe system, swipe in, and then I can help you with whatever you need."

Don Undeen
Maker Hub
Georgetown U
Washington DC



Q We have users who come to the space to work on projects for a while, then drift off when they have completed their project. Or they show up when required for their class, but don't become invested in the space. How do we foster deeper, long-term engagements with the makerspace?

A makerspace thrives when its users become invested in the long-term success of the space. This often happens because the space means something to them and they feel they can contribute to it. It becomes their space. To ensure its livelihood, a makerspace needs to foster an environment for deep engagement and form a community with an ethos of sharing, resourcefulness and well-being.

Here are some practical ideas to consider for activities and projects that encourage long-term engagement:

- Regular meet-ups, such as potlucks, movie nights, knitting, gardening, etc
- Team building activities
- Carefully designed projects for various levels of challenges
- Design challenges/projects that can be done within a specific timeframe
- Projects relevant to the community's needs and goals
- Projects that involve teamwork so members can support each other
- Multi-stage projects
- Business-oriented prototype development and innovation

Q Some of our users rely a lot on our facilitators to help them with every aspect of their projects. They seem to be intimidated by the tools, or unsure of how to use the space on their own. How do we foster a sense of autonomy in our users?

A makerspace can only scale up when its members start taking control of their own “maker on-ramp”. Facilitators need to use a fine blend of helping people develop their autonomy while remaining accessible for technical support or problem-solving. Here are some tips to foster autonomy in users:

Design of the space

- Prepare intelligible documentation and safety rules
- Prepare clear labels for "safe" tools vs "danger bits"
- Offer appropriate tools to the community skillset
- Keep space for growth (ex. If the community is interested in sewing, let them co-design a sewing corner)

Activities with multiple points of entry:

- Independent activities
- Workshops
- Mentorship
- Match-making events
- Provide opportunities for confidence building
- Offer projects that gradually increase in complexity/difficulty
- Train staff to recognize when someone is struggling
- Ensure users can get help from people "on the spot" - without appointments during open hours

Culture

- Encourage trial and error
- Recognize users
- Guide users to do their projects instead of doing projects with them
- Make with users, rather than for users
- Refer novice users to more experienced users to promote user-to-user knowledge exchange

Q Our users come to the makerspace and use the tools, but they don't interact with each other very much. If they connected with each other in the space, they might stick around longer, learn from each other, and become bigger supporters of the space. How do we foster a sense of community in our makerspace?

Design of the space

- > Create "Hang-out" spaces for conversation and casual interaction
- > Create a space identity - unique tools or projects
- > Allow the community to build the space (decorations, interactives, etc)
- > Provide a food zone

Culture

- > Create a safe space for people to experiment, fail and learn
- > Learn people's names
- > Celebrate people's projects
- > Connect people with shared interests
- > Recognize the value of each user's skills and knowledge
- > Take the time to get to know people and introduce them to one another
- > Involve the community directly in determining the rules, policies, and code of conduct

Case Study: The Georgetown University IdeaLab Washington, DC, United States



“Adjacent to the Maker Hub makerspace, the IdeaLab was explicitly designed to provide relief from the sensory overload of the Maker Hub, where makers can relax, recharge, and discuss ideas. The Idea Lab is equipped with soft lighting, comfortable chairs, a LEGO table, colouring supplies, and conversation-starting games like StoryCubes. Examples of maker projects such as pillows, scarves, and lamps are available for visitors to use and to inspire new projects.”

Don Undeen, Georgetown U. Maker Hub
<https://library.georgetown.edu/spaces/idea-lab>

Q Our community is changing. How does our makerspace evolve to meet the changing needs of our local communities?

Here is some advice to continue being relevant

- Listen to your community
- Evolve with the community
- Offer tools, equipment, materials and projects that have a point of reference to people's lives
- Create good memories associated with the space
- Note recurrence of interest in a certain topic
- Adapt tool/equipment to interest
- Learn about backgrounds/culture/interests/passions

You can leverage your current community connections to

- Seek experience and knowledge by meeting the experts and the community at large
- Tap into evolving needs - ex. emergence of outdoor learning, connections to nature
- Keep an eye out for business opportunities
- Hire diverse staff/ facilitators from the community
- Mix spaces, mix human minds, mix, mix, mix
- Find complementary knowledge in the community
- Develop continuity between existing members and new members, by connecting them for projects and ideation

Q We have a solid group of makerspace users. Many of them would contribute to the space if we asked them to. What can our users do to contribute to the sustainability of our makerspace?

Inviting your members to help is way of allowing them to build a sense of ownership, belonging, and responsibility for the space. Their contributions could be simple and practical, like cleaning and organizing, or based on their interests and experience in the space.

Simple contributions

- Document project and activities
- Help during makerspace open-house days
- Write blog entries or post activities on social media to show the work of the users
- Organize materials
- Clean

Design activities

- Listen, share criticism, help solve
- Ensure that the maker mindset is present
- Take initiative to make positive change
- Make the space essential
- Let people tell the stories
- Visit other makerspaces

Outreach activities

- Create a community / connect with new users
- Showcase creations
- Tell the success stories to funders / decision makers
- Spread the word, bring your friends in
- Practice facilitation skills, contribute to a welcoming environment
- Become an ambassador and promote the makerspace

Note: This should not be seen as free labour. Volunteers should have some perks. These could be free use of materials, access to the space during closed hours or free training to develop specific skills. You can also treat your volunteers to lunch or do a special event for them.

5. Making in Formal Education Contexts

If you are reading this, the maker education trend has probably reached your school. It's exciting, but maker education poses several challenges. We know that STEAM (science, technology, engineering, arts and mathematics) activities are great, but they are not sufficient to create the ethos of sharing, resourcefulness and care that we find in maker culture. During the unconferences, we collated a series of recommendations for teachers, principals and leaders in education who are interested in integrating making into formal education contexts. What follows is a series of Q&As that stem from conversations we held with participants during the unconference event on that topic.

Q I am a TEACHER and I want to integrate making into classroom projects, but I have little to no experience with making. What should I do to prepare myself to make with my students?

Try it!

Students can learn a lot with cardboard, glue and scissors, and so can you. Maker education is about the creative problem-solving mindset and the design process, which you and your students can develop starting with very simple projects.

Learn the basics

When making, students should be encouraged to find their own solutions, but it does help to know some of the basics so that you can direct your students to helpful resources. Some useful beginner projects include basic electronics like how simple circuits work, basic coding like block coding or Scratch, introductory 2D and 3D design, and how to safely use manual tools like hammers, saws, and screwdrivers. Remember, you don't need to be an expert, but having basic skills can be helpful as you accompany your students.

Make connections with the curriculum

Making should help support what you're teaching, not add to your load. First, identify some concepts from the curriculum that you want to target. Second, design a maker activity or project that will either address a problem related to your target concepts, or require students to develop the skills or competencies you have targeted through the process of making. This can be linked to the Digital Competency Framework or the cross-curricular competencies from the QEP.

Make connections with the real world

Making is an excellent way to help students connect what they are doing in school with real-world problems and professional practices. Design projects that address real societal issues and use processes that reflect professional practices so that your students can have a deeper appreciation of what they are learning in school.

Let your students learn on their own

A lot of the learning that comes from maker education is through independent or collaborative problem-solving. Students can't learn from making if you do it for them, so let them find the solutions by themselves and only step in if you see that they're really stuck. Observe them, guide them, and keep your hands off their projects when possible.

Connect with other teachers

Maker projects are those that involve multiple disciplines. Connect with teachers from different disciplines and design a project that covers curriculum content for both of your teaching areas. This helps students appreciate the interdisciplinary nature of most real-life situations. It also helps you because working as a team with other teachers can remove some of the stress from your shoulders as you share the responsibility for the project.

Professional practices through making

A lot of what we do in schools is designed to help students learn concepts, and very little is linked to the professional practices around these concepts. Our science experiments, if done following the instructions, will all come up with the same result. But in reality, this is not how science is done, which means our students don't actually know how scientists work. Open-ended maker projects offer students the opportunity to solve problems without a script and experience more closely what professionals in STEAM actually do. They also offer students the opportunity to interact with STEAM professionals as they seek ideas and solutions for their projects, giving them even more insight into these professions.

Some Resources to Look For

One organization's trash could be your makerspace's treasure!

Look for offices that are updating their tech; the old stuff is often still good.

E-waste recycling centres are another good source of interesting and useful materials.

See if there's a "Tool Library" in your area that can lend you equipment while you build up your own workspaces.

Bookstores and Libraries often throw out old media that can be used for art-making projects.

If your area has a university, make note of their residential move-out dates, when students discard everything. they're not taking home with

Connect with your local or online maker community

Makers are often willing to help! Connect with your local maker community or with an online community so that you can reach out whenever you encounter a problem you're not sure how to resolve. Many libraries now have makerspaces with trained librarians or technicians who can offer invaluable expertise and resources.

Connect with your students' parents and experts in your community

Many of your students' parents or community members have expertise related to maker education. Ask them to share their expertise with the class and to volunteer their time and help with a project. This can be a great way for the students to see how what they are doing in school is related to what people are doing in real-life professions.

Find out what resources are available to you

Your school, local library, or local community makerspace may already have many resources or tools that you can borrow or use for your maker projects. Find out what is available to you so that you can design your projects based on the resources you have at hand.

Q I am a **TEACHER** and I know my students will love maker projects, but what will they learn?

Manual and technical skills

Maker education offers students opportunities to learn manual and technical skills. They can learn to use 3D printers, vinyl cutters, manual and power tools, 2D and 3D design, robotics and coding.

The curriculum

Carefully designed projects will solidify curriculum concepts covered in class. Yes, maker projects will all look different, but with the right constraints, all students can learn about the same target curriculum content through a maker project.

Creativity and problem-solving

The design process requires many different skills to get from idea to working prototype. As students go through the creativity process they develop their creativity and problem-solving skills.

STEAM concepts

Maker education typically involves the authentic application of many STEAM (science, technology, engineering, arts and mathematics) concepts. It can be an excellent way for students to use and further develop their STEAM knowledge in a way that makes sense to them.

Focusing on all the letters in STEAM

With the push from STEM to STEAM in schools a lot of attention has been given to arts, but components of the E in STEAM are often misinterpreted. There are no compulsory computer sciences courses yet. The science and technology curriculum in elementary and secondary has two processes built in – the scientific method and technological design. Technological design is often overlooked and the students rarely have the opportunity to develop design skills. Where science tends to endeavour to discover the principles about what already exists, engineering tends to focus on what new things can be created. Maker projects can bring equilibrium in STEAM by helping students unleash their

The Importance of the Maker Mindset

One of the most powerful things about engaging in making is the mindset students can develop through such experiences. The “Maker Mindset” is a set of dispositions that empowers people to have more confidence in their abilities and be more proactive in making positive changes to their environment. People who have developed the maker mindset are creative risk-takers as they are prepared to fail, iterate and never give up. They are ready to venture into uncharted territory and learn something new. They collaborate with one another, sharing ideas, processes, and solutions. They are prosumers, contributing to development of new ideas and products, not just consumers of what is commercially available to them. Helping students develop the maker mindset in addition to the skills they gain from making provides them with the right attitude to face

Interpersonal skills

Maker education involves working in collaborative groups. Well-designed maker projects can challenge students by drawing on different people’s expertise, requiring them to seek the input of peers and makers in the local community.

Personal growth

Making promotes the growth mindset, where students can develop their self-confidence and become lifelong learners. Making helps students develop important attitudes like persistence and resilience and learning from failure. Well-designed constraints can help students become resourceful as they seek to solve a problem with the resources they have at hand.

Digital citizenship

Digital technology has become a major part of our everyday lives and so it is essential that students learn to use and produce technology ethically and sustainably. By learning how technologies work, students can be more critical about the technology they encounter and even produce as they become more proficient with it.

Global citizenship

Maker projects often tackle community or global issues like climate change, gender equality or the consequences of poverty. In these projects, students develop a better understanding of the issue at hand, as well as empathy for those involved, leading them to be better global citizens.

Q I am a **TEACHER** and want to integrate maker activities in my classroom, but how can I evaluate student learning from making?

Concepts from the curriculum

Ask students to describe what they've learned about the curriculum concepts you are targeting. Because maker projects can go in different directions students may learn slightly different aspects of concepts being studied, but they should all have a good understanding of them.

Cross-curricular competencies

These are often the hardest to address in teaching and maker education is an excellent way to tackle many of them. Competencies like communication can be observed in many aspects of making like how students communicate with their peers, how they communicate with online groups as they seek solutions for their project, and how they communicate their learning through a process journal or a final presentation.

Maker projects for the less obvious disciplines

Integrating making into STEAM classes seems like an obvious choice, but what about disciplines like language arts, history, or philosophy? Finding a connection between the humanities and language courses and maker projects may take a little more creativity, but it can certainly still be done and result in outstanding learning experiences for your students (not to mention fun!). In history class students could create a diorama of a historical event with laser cutting or 3D printing (or even just cardboard!). In English class they could create a prototype of a futuristic device from a sci-fi novel they are reading or a costume of one of the characters. Perhaps students want to create a stop-motion film to make a hard-to-understand philosophical concept more concrete for their younger peers. No matter the topic, maker projects can be integrated to offer students the opportunity to engage more deeply with the material.

Evaluate the process not the product

Maker education is about the process and the learning that happens when things go wrong. If evaluation is solely about the final product, students may be reluctant to take risks and create something new in fear that it might fail. By evaluating the process, students may not succeed in creating a working prototype, but they may learn a lot more along the way and be credited for it!

Use rubrics or clearly defined learning criteria

Letting students know what it is you want them to learn helps emphasize what is important. For example, if you want students to develop their creativity, indicating creativity as one of the learning criteria and clearly operationalizing it can motivate students to try something new or original. An example of a maker rubric can be found here: https://www.edutopia.org/sites/default/files/resources/samplerubric_lisayokana_1.pdf

Process journals and portfolios

Having evidence of student learning is of essence. Using process or reflection journals where students describe their process, and portfolios containing samples of students' work, can demonstrate the progression of students' learning as they become more experienced with making.

Self-evaluation

Self-evaluation is an excellent way to empower your students and grasp what they think they are learning. Not only does it help students self-regulate, but it can also help you gain some insight into what they have learned that may not have been visible on the surface.

Peer-evaluation

Peer evaluation has three great benefits:

- Students often understand feedback better when it comes from their peers as they are at a similar developmental level.
- By practising assessing someone else's projects, students can often improve their skills at assessing their own work.
- As a teacher, you may not be aware of all of the experiences that students are having while working on a project. Through reading the peer feedback, you may be able to gain some insight into events that occurred when you were busy with other students.

How Making Addresses Cross-Curricular Competencies: Examples using the Québec Education Program

Many education systems now have cross-curricular competencies as part of their curricula. These competencies can be challenging for teachers to address in their teaching. The following provides examples of how maker learning experiences can address cross-curricular competencies using the nine cross-curricular competencies identified in the Québec Education Program:

Uses information

As students seek solutions to create their project, they will need to seek out information, critically evaluate the usefulness of that information for their project, and make use of the information by applying it to their project.

Solves problems

Maker experiences that require students to find their own solutions to problems will help them learn how to think deeply about a problem, think of possible solutions, persist when the answer doesn't come immediately, and find alternative sources for ideas when they cannot think of the solution themselves.

Exercises critical judgment

The maker process requires critical judgment from start to finish. As students decide on the feasibility of project ideas or designs, tinker on the best approaches to take to achieve their project goals, and sift through the information they find online as they work on their project, they have to make decisions to decide what is valuable and credible information and what is not.

Cooperates with others

Collaboration is central to making whether it be as part of a group project, sharing tools and equipment with others using a space, or seeking solutions from others.

How Making Addresses Cross-Curricular Competencies: Examples using the Québec Education Program

(continued from previous page)

Uses creativity

Whether it be the aesthetic aspects of a project or creative problem-solving, maker learning experiences will be sure to draw on and further develop students' creativity.

Adopts effective work methods

Maker projects are ideal for students to learn how to plan their work process, reflect on how they are progressing, and learn to adjust when necessary as they are responsible for the entire progression of the project. They can use design thinking or other creative processes – an often unique experience for students while in school.

Uses Information and communications technologies (ICT)

Whether it is to seek information for their project or an integral part of what their project is, students will further their ICT skills through maker experiences. Even for projects that only use cardboard and glue students are likely to seek information online or to contact others using ICT.

Achieves their potential

To achieve their potential, students need to know themselves, their strengths and areas for growth, their preferences, and their interests for potential careers. Through a variety of maker projects, students can explore different interests, develop new skills, and experiment with approaches used in a variety of professions.

Communicates appropriately

Whether students are communicating with their team, people from the maker community, or explaining to their teachers what they've learned, students will certainly further their communication skills through making.

Q I am a school PRINCIPAL and I am trying to encourage my teachers to integrate making into their teaching practice. What can I do to help support teachers with maker education?

Create conditions for maker education in the school

Make sure a team is on board and that they will do their best to reduce the barriers that teachers may encounter. Identify a small team to lead maker education initiatives. The outcomes of a maker education program are heavily dependent on the sustained efforts of shared leadership and communities of practice or learning communities. If possible, hire specialized staff with experience in maker education who can support the teachers.

Give teachers a safe professional development space to try things and possibly fail—a lot of learning from making comes from failure and this should be true for the teachers as well. Be open to changing how things have always been done to allow for the projects that go outside of the box.

Celebrate the successes of your teachers' and students' work by holding school fairs or exhibitions and highlighting student work on your school's website

Provide professional development

Most of your teachers may be completely new to making. Provide them with opportunities to learn some of the basic maker skills and to make connections with the curriculum.

Provide support

Having experts available for consultation or mentors who can support teachers in their first experiences with maker education can really help teachers get on their feet with making in the classroom.

Give your teachers time

It takes time to learn a new skill and making is no exception. Give teachers release days for professional development and time in their weekly schedule to plan maker projects and collaborate with other teachers. Ideally, create a community of learning around making.

Provide tech support

Makerspace technologies need maintenance and troubleshooting, so ideally a technician should be available to take on this role. If one is not available, provide at least two teachers with the training and time to be able to take on this role.

Provide space

Some maker projects may require more space for safe manipulation of tools or for prototypes to be tested than a classroom can provide. Dedicating a room or even occasional access to the gymnasium for maker project purposes can allow for a much greater array of maker projects. Storage space is also essential as most maker projects will not be finished in one session.

Leverage your students' knowledge

Sometimes students' technological knowledge exceeds their teachers' knowledge. Use that knowledge by inviting students to help their classmates

or younger peers, or even their teachers! Making is a community affair and there is no better way to demonstrate that than by including the students as leaders.

Partner with community makerspaces

Many community organizations and makerspaces who specialize in learning through making can be an invaluable resource. Partner with these makerspaces as they can help support your teachers and students. Working with these makerspaces can also be a great way to try out new tech so that you can determine what would work for your school before making any costly purchases.



An obstacle course set up in a separate room allowed a student to work on a robot for several weeks without having to remove and replace the course each time he worked on the project.

Leveraging student knowledge: An example of high schoolers helping elementary students make flashlights



Ideas know no boundaries and no teacher knows this more than Serge Beaudoin from Collège Saint-Sacrement. Serge spearheaded a flashlight challenge for his students in collaboration with Léopold-Gravel alternative school and Concordia University. The project was all about highlighting ideas, learning and discovering and the challenge was to research, plan and build a flashlight and then present the process and results. Centered around the Design Thinking process (empathize, define, ideate, prototype and test), students were challenged to research, plan and build a flashlight and then present the process and results. Working together in groups of 2 elementary students, 2 high school students and a university student, with Serge overseeing the overall project progress, the high school students tried to understand their younger peers' ideas for a flashlight design, defined these ideas with the elementary students, and ideated some designs in TinkerCAD for their 3D models and circuits. The university student assisted with the prototyping and presented the prototyped design within a maker kit for the younger students (and their parents) to build and test. All the students took pride in their design and their parents took pride in their children. This provided older students with the opportunity to take the lead on design projects and contribute to the education of their younger peers. Younger students also benefited

Q I am a **PARENT** or a **COMMUNITY MEMBER** who wants to support the local school with their maker program. What can I do to help?

Give your time

Teachers have very little time. Volunteer to help a teacher prepare the materials for a project or find some resources that they may need. Help out in the class while the students are working on the project to help with large groups who are engaged in making

Share your expertise

If you have expertise related to maker education you can share it! It will also be a great way for the students to see the expertise of members of their local community.

Share tools, resources or funds

Students can learn a great deal through making with basic materials like cardboard and recycled plastic bottles, but adding the personal touches through paint or using more precise fabrication equipment such as 3D printers can make a project even better. These things cost money that schools often don't have. If you have the means, consider donating equipment, materials or tools, or even donate some funds that the school can put toward their maker program.

Case Study: Maker Neighbours



“Our makerspace isn’t open to the general public, so we developed the “Maker Neighbour” program, whereby local experts in electronics, printmaking, etc. could get access to the Maker Hub in return for serving regular volunteer hours. This gave us access to expertise we didn’t have in our university, while also connecting students with project support, mentorship, skills training, and job opportunities. Our Maker Neighbours really enjoyed being a part of our community, so everyone benefitted.”

Don Undeen, Georgetown University Maker Hub

Q I am a **LEADER IN EDUCATION** and I want to support schools in their efforts to integrate maker education. What can I do to be supportive of these programs?

Create a culture of making in your school system

- Get everybody on board. Get the parents and the students just as convinced as the teachers so that all stakeholders are motivated to make it work.
- Make making a part of the curriculum. The curriculum is the teachers' priority, so if maker education is not in the curriculum, it is not guaranteed to happen in the classroom, especially if teachers are in a crunch for time. Make sure maker education is part of the programming.
- Be flexible and open-minded to integrate all types of making including STEAM activities, knitting, button making, etc.
- Celebrate the work done by students and teachers at regional fairs or exhibitions and by having maker profiles on your website.

Provide training

Funding for equipment is important, but without the training teachers will not be able to use it. Make sure to reserve funding for training and professional development so that the funds you've put into the equipment don't go to waste.

Provide funding for consumables

Maker activities use a lot of materials that often cannot be reused, such as the filament used for 3D printing. Be prepared to set aside funds for the purchase of consumables so that students can make throughout the year and not just while supplies last.

Provide resources

Providing resources such as a website of projects that link to the curriculum can help teachers immensely as they plan new projects. Ideally, pedagogical and RÉCIT consultants can be involved in supporting the implementation of maker education in schools.

Did you know? LEARN Québec has tons of resources on their website.
<https://dca.learnquebec.ca/>

Be flexible

Maker education programs require schools to adapt to the process of making. Be flexible and consider requests that go outside of the usual boxes.



6. Maker Kits

Ouf!

Maker kits are not all created equal and they often ignite discussions between makers who disagree on the topic.

Some kits can be very useful, while others can be more recipe-like and do not yield the desired learning outcomes that help makers become more autonomous or develop the maker mindset. This section attempts to debunk the issues around maker kits. What follows is a series of Q&As that stem from conversations we held with participants during the unconference event on that topic.

Q What is a “maker kit”?

A Maker Kit is a grouping of physical components or parts which can be assembled for one or more projects. Kits that can be interpreted in many ways, expanded in multiple projects, reusable and that offer detailed instructions are often the most useful kits. Several factors can be useful to make decisions to adopt kits:

Interpretability

Some kits can make only one project. Ask yourself: Does the kit provide components to make more than one project?

Expandability

Some kits can create a wider range of projects because additional parts can be added. Ask yourself: Is the kit compatible with more complex versions?

Reusability

Some kits can be disassembled and used again. Ask yourself: Can the kit be used more than once?

Detailed instructions

Some kits provide detailed instructions for completing a specific project. Ask yourself: Does the kit provide more general instructions and resources to use for a wide range of projects?

Maker kits are material manifestations of structured learning activities that make some decisions for the user. This includes selecting the right parts for a project, providing pre-made PCBs, enclosures, or other customized parts, providing clear instructions, ensuring that all components are compatible, so that the user can focus on other goals (learning manual/technical skills, creative experimentation, getting the final project, building confidence, etc). They contain the tools and parts to carry out a project, but sometimes they are limiting.

Case Study: Musée de l'ingéniosité Joseph-Armand Bombardier: How to create a kit with a pedagogical intention



Pedal to the Metal is a techno-pedagogical activity offered by the Fab Lab of the Musée de l'Ingéniosité J.-A. Bombardier to elementary school students. The activity includes a theoretical component on types of energy as well as a hands-on "tinkering" component. In its

virtual form, the classes are given components of a small wooden vehicle, made largely by a laser cutting machine prior to the activity. The kits include the structure of the vehicle, in six pieces, two wheels of small, medium, and large sizes, two wooden dowels serving as axles (one of which with a screw), and several rubber bands of different sizes. These kits are easy to mail in large quantities and also allow students to assemble their own educational material. The "hands-on" activity then consists of finding the combination of parts that will allow the rubber band-powered vehicle to travel the greatest distance possible. The only rules are to change only one component per trial and to note each modification and each result in the "engineer's notebook".

Hubert Cousineau

Coordonnateur Fab Lab et Technopédagogie

<https://museebombardier.com/en/activites-scolaires/pedal-to-the-metal-2/>

Your Kit Planning Workbook

In the following pages are a series of worksheets and steps to guide you toward the creation of maker kits that meet your goals and serve your communities. You are encouraged to go through these steps of analysis, design, planning, implementation, and dissemination in close collaboration with your stakeholders, so that the resulting kits are the best they can be.

1. Goals

Experiential goals

E.g. learning, confidence, experimentation, etc.

Conceptual goals

What are the creative and technical concepts to be covered?

2. People

Users

What are their skill levels and interests?

Facilitators

What are their skill level and expertise in regards to the concepts they're trying to teach with this kit?

What is their capacity to do additional training?

Reusability

Does the kit need to be re-used?

Will the user be able to take home the final result or do they have to take it apart for another user?

Instructions

Does the kit need to provide detailed instructions for a specific project, or more general instructions for a wide range of projects?

5. Numbers

Funds and numbers around kits

Budget	
Total Number of users	
Number of users we need to support at the same time	
Number of kits to make or buy	
Number of uses these kits need to last for	
Time required for kit activity	
Preparation (E.g. 60 min.)	
Pre-activity discussion (E.g. 30 min.)	
Assembly Activity (E.g. 90 min.)	
Post-activity discussion (E.g. 30 min.)	
Clean Up (E.g. 20 min.)	
Total Time	

6. Teaching

What skills do YOU need to be able to teach with this kit?

What decisions do you want the user to NOT have to make? What do you want to make easy for them?

What can be prefabricated for the user to allow them to focus on specific aspects of the learning experience?

E.g. Pre-cut wood or plastic wheels to create a robot.

Which constraints do you want to embed as a learning opportunity?

What instructions will you provide?

What format do they need to be in?

E.g. video, annotated pictures, booklet or QR code, etc

How will you provide technical support if problems should arise?

7. Resources

Physical

Consider using recycled or waste materials.

Human

Consider reaching out to people who have more experience designing and making kits for advice and suggestions.

8. Prototyping

A. Make a prototype

Consider the most cost-effective and time-efficient methods of fabrication.

Ask yourself:

Can you get your community involved in making the kits?

Which components do you need to outsource due to lack of skills or tools?

D. Repeat

until satisfied with the kit.

B. Pilot

test with a small group of typical users and collect feedback.

C. Make adjustments

based on the feedback.

Change your responses to above questions based on what you've learned.

9. Scaling Up

Make as many kits as needed.

Consider how the kit will be packaged and distributed.

Think about sustainability issues and carbon footprint.

10. Next Steps

Make sample projects to give inspiration for users to use the kit in other ways.

Consider new applications for the kit.

Share the kit design and lessons learned with others so that others can create the kit or avoid pitfalls when creating their own.

Think of who else could benefit from the kit other than the audience it was originally created for.

Sell the kit and
\$\$Get Rich!\$\$

Make connections between the school curriculum and the concepts learned when using the kits so that schools can benefit from using the kit.

Celebrate what people make with the kit (expo, party, social media)!

Case Study:

Robot in a Can: Lessons about Making a Kit From Ben Douek



Inspired by an innovative teacher in school, Ben wanted to help young people who were not so fortunate to have such a knowledgeable teacher by providing them with a kit that would help them learn about coding and physical computing. After several prototypes, Robot in a Can (www.robotinacan.com) is now being used in schools and by youth who are motivated to learn on their own.

Here are Ben's tips if you want to create a kit:

Plan in as much detail as possible in the beginning to avoid time consuming and expensive mistakes in the long run.

Connect with people who have done something similar to what you want to do to find out if they have suggestions for companies to contact or processes to use that will save you time, money, and frustration.

Create connections with local and online maker communities to ask for help as they may already have the solution to glitches in the code that can create significant delays in a kit's development.

Don't skip out on the usability testing to reveal many shortcomings that may create frustration for the user. Don't ignore anything! Discovering minor issues can make a big difference in the long run.

Outsource elements of your kit to save you time and to make the kit look more polished. Kit creators tend to think that everything in the kit has to be DIY. Many companies around the world can create parts based on your specifications, such as printed circuit boards, cheaply and with quick turnaround. Be aware, however, that intellectual property rights vary from country to country and that there may be risks associated with providing some companies with your designs.

Credits

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Topic 1: Lessons Learned from COVID-19:

What to Do When Your Makerspace is Closed

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Topic 2: Building a Network

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Topic 3: Preparing Facilitators

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Topic 4: Building Community

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Topic 5: Making in Formal Education Contexts

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Davidson, A.-L., Duponsel, N. (2022). How to bring your class in a makerspace and make the best of it. *Engaged Learning. Teaching in the Digital Age. Computer Programming: How to Develop this Skill at School. Spring 2022*, 21-23.

Topic 6: Maker Kits

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Page 81.....	Image Credit: Museum of Ingenuity
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